

# Femoroacetabular impingement and osteoarthritis of the hip

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## Abstract

**Objective** To outline the clinical presentation, physical examination findings, diagnostic criteria, and management options of femoroacetabular impingement (FAI).

**Sources of information** PubMed was searched for relevant articles regarding the pathogenesis, diagnosis, treatment, and prognosis of FAI.

**Main message** In recent years, FAI has been increasingly recognized as a potential precursor and an important contributor to hip pain in the adult population and idiopathic hip osteoarthritis later in life. Femoroacetabular impingement is a collection of bony morphologic abnormalities of the hip joint that result in abnormal contact during motion. *Cam-type FAI* relates to a non-spherical osseous prominence of the proximal femoral neck or head-neck junction. *Pincer-type FAI* relates to excessive acetabular coverage over the femoral head, which can occur owing to several morphologic variants. Patients with FAI present with chronic, deep, or aching anterior groin pain most commonly in the sitting position, or during or after activity. Patients might also experience occasional sharp pains during activity. A thorough history should be taken that includes incidence of trauma and exercise frequency. A

physical examination should be performed that includes a full hip, low back, and abdominal examination to assess for alternate causes of anterior groin pain. Diagnosis of FAI should be confirmed with radiography. Femoroacetabular impingement can be managed conservatively with rest, modification of activities, medications, and physiotherapy, or it can be treated surgically.

**Conclusion** Femoroacetabular impingement is an important cause of anterior groin pain. Early recognition and intervention by the primary care provider might be critical to alleviating morbidity and preventing FAI progression.

## EDITOR'S KEY POINTS

- Femoroacetabular impingement is a prevalent condition that is well described but that has been largely unknown to health care providers outside the specialized fields of musculoskeletal medicine and surgery.
- For patients with persistent hip pain for whom conservative management has failed, referral to an orthopedic surgeon experienced in this area for further evaluation might be prudent.
- Femoroacetabular impingement is an important cause of anterior groin pain and might be a cause of hip osteoarthritis in the adult population. Prevention of osteoarthritis and resultant total hip arthroplasty might be possible; therefore, early recognition and intervention make the role of the primary care provider critical.



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A growing body of evidence supports the theory that idiopathic hip osteoarthritis (OA) might be caused by femoroacetabular impingement (FAI), although it was previously thought to be the natural result of aging.<sup>1-6</sup> Femoroacetabular impingement has been identified as an important cause of hip pain in young adults aged 15 to 50 years,<sup>2,3,6-8</sup> which bridges the diagnostic gaps between age groups with well established pathology such as limping children and elderly patients with symptomatic OA.<sup>9</sup>

The impingement results from subtle, asymptomatic abnormalities that cause abnormal contact between the femur and the femoral head-neck junction, or acetabulum, during motion.<sup>4</sup> Femoroacetabular impingement has now become the most common indication for hip preservation surgery.<sup>10</sup>

A thorough history, physical examination, and radiographic assessment of the hip are vital components of the workup for hip pain in this population. Consultation with health care providers in musculoskeletal disciplines (eg, orthopedics, rheumatology, sports medicine, physical therapy) and imaging specialties

is necessary to achieve timely and appropriate diagnosis and treatment.

Despite its prevalence and causal role in hip OA,<sup>1-5,11</sup> many patients with symptomatic FAI experience substantial delays in diagnosis, often longer than 1 to 2 years.<sup>12</sup> They are also often misdiagnosed and receive inappropriate, ineffective, or harmful investigations and treatment.<sup>12,13</sup> Information available to patients and doctors on the Internet is of overall low quality.<sup>14</sup> These delays and inappropriate treatment occur despite the fact that patients with FAI present with fairly consistent signs and symptoms and identifiable abnormalities on plain film radiographs.<sup>12</sup>

Although the term *FAI* was first introduced in the mid-1990s and FAI is now well described, the literature on FAI has been published largely in orthopedics, rheumatology, and imaging journals. As the primary care physician will in almost every instance be the first physician to see a patient with FAI, we aim to provide a clinical review for primary care physicians and to underline the clinical importance of FAI.

### Sources of information

PubMed was searched up to December 31, 2014, for relevant articles regarding the pathogenesis, diagnosis, treatment, and prognosis of FAI. Search terms included *femoroacetabular impingement*, *FAI*, and *hip osteoarthritis*.

### Main message

**Pathophysiology.** Femoroacetabular impingement is a collection of bony morphologic abnormalities of the hip joint that cause abnormal contact during motion. There are 2 main types of FAI, based on subtle bone morphology changes on either the femoral or the acetabular side of the joint.

**Cam-type FAI** is caused by an irregular osseous prominence of the proximal femoral neck or head-neck junction (**Figure 1**).<sup>15</sup> This bump can result in impingement and abrasion of the femoral head-neck junction on the acetabular rim.<sup>16</sup> This can be identified on various views of hip radiographs.

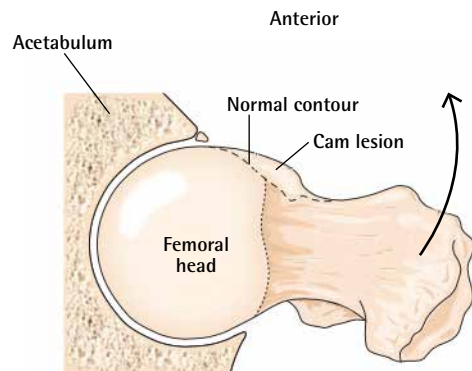
**Pincer-type FAI** is caused by excessive acetabular coverage of the femoral head (**Figure 2**),<sup>15</sup> which can occur owing to several morphologic variants (eg, acetabular retroversion, acetabular profunda, acetabular protrusion). It can be identified on anteroposterior hip radiographs.

Most patients have both deformities, resulting in mixed FAI pathology.<sup>2-4</sup>

The various forms of FAI might cause early contact within the hip joint between the femoral head and neck and the acetabulum, resulting in hip pain, accelerated chondrolabral wear, and the potential for accelerated cartilage degeneration.<sup>4,5</sup>

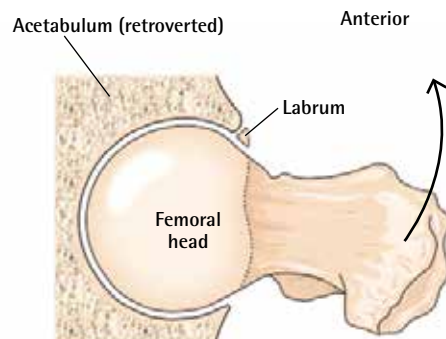
It has been suggested that FAI is the cause of most cases of nondysplastic hip OA, including that previously

**Figure 1. Cam impingement**



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**Figure 2. Pincer impingement**



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classified as primary (or idiopathic) OA.<sup>1,6</sup> In an early study that predated the term *FAI*, Harris identified subtle bony abnormalities in 90% of patients with primary hip OA.<sup>1</sup> In a large population study of 4151 individuals in Denmark, FAI deformities were found in 71% of men and 37% of women with hip OA.<sup>17</sup> Subclinical FAI deformities are independent risk factors for and have been significantly associated with the development of radiographically confirmed OA (odds ratio 1.05; 95% CI 1.01 to 1.09 for each degree increase in alpha angle above 65°) in a 20-year longitudinal cohort study, with a strong exposure-dependent relationship between increasing severity of FAI and increased risk of OA.<sup>18</sup> In a study involving patients younger than 55 years undergoing total hip replacement, 36% of the subjects had definite FAI.<sup>19</sup> The prevalence of symptomatic FAI in the general population is not yet fully known, although one study has shown it to be approximately 10% to 15%.<sup>7</sup>

Although the exact pathogenesis of FAI remains unclear, most research evidence attributes it to a

combination of congenital bony deformity and developmental or acquired overuse causing repetitive abutment and wear of the hip joint.<sup>6,20</sup> The current thought regarding FAI is that it causes repetitive insult to the surrounding skeleton and cartilage during growth and certain activities. In support of this statement, it has been found that high-level athletes had a higher prevalence of FAI diagnosed clinically and via imaging compared with amateur athletes and non-athletes.<sup>21,22</sup> Although people with normal bony morphology of the hips can also acquire chondrolabral damage via overuse and injuries, patients with FAI accumulate the wear and tear at a faster rate owing to altered morphology and motion of their hip joints.<sup>7</sup>

Several risk factors have been identified for FAI, which include activities involving repetitive hip motion, high-level sports, pediatric hip disease (slipped capital femoral epiphysis and Legg-Calvé-Perthes disease), femoral neck fractures, and previous hip surgery.<sup>20-23</sup>

**Clinical presentation and patient history.** Patients with hip pain most often initially present to their primary care providers, making recognition of this recently described condition clinically important, especially as prevention of progression to OA might be possible.

Patients presenting with symptomatic FAI are often physically active adults between the ages of 25 and 50 years.<sup>8,15</sup> Patients present with chronic, deep, or aching anterior groin pain most commonly in the sitting position, or during or after activity. Patients might also experience occasional sharp pains during activity. The frequency and severity of pain increases as the acetabular labrum and articular cartilage degenerates. It is helpful to have patients directly point out the location of their pain, as many patients refer to their lateral thigh or buttock region as their hip, rather than the anterior groin, which is the most common site for pain arising from the hip, at least early on.

The patient's age and a thorough history of the presenting condition should be obtained. The history of the presenting pain should include the presentation, duration, quality, radiation, severity, timing, progression, and alleviating and aggravating factors. The presence or absence of trauma is important. Other issues the physician should ask about include current and past medical and surgical history, medications, allergies, family history of musculoskeletal disorders or rheumatologic disorders, and personal history of smoking and alcohol or drug use. It is also important to obtain a vocational history and current and past exercise history. Sports that are associated with a higher incidence of FAI are those involving repeated and excessive flexion of the hip (eg, hockey, skiing, soccer). Chronic anterior groin pain with an FAI pathogenesis is commonly misdiagnosed as groin pull or strain.

Patients with symptomatic FAI typically have pain that is worse with activities, especially ones involving high flexion angles or sustained flexion loading (eg, skiing, skating, squatting) or rotation (eg, tennis, basketball) of the hip joint. Patients might have pain while getting in and out of a car, as the motion involves the hip joint undergoing loaded rotation while in flexion. Weakness and numbness are not commonly associated with FAI, and lumbar spine pathology should be suspected in such patients.

**Physical examination.** For patients presenting with hip pain, it is important to conduct a full hip, low back, and abdominal examination to assess for alternate causes of anterior groin pain.

Physical examination of the hip joint includes inspection, gait observation, palpation, determination of active and passive range of motion, and specialized tests.

**Inspection:** Inspect the standing posture for any obvious misalignment or abnormality. Recording the true and apparent leg length. The Trendelenburg sign (ie, abductor weakness) is sometimes observed.

**Gait observation:** The clinician should focus on the stance and swing phases of the gait, range of motion, and the presence of any limping or antalgic steps. Decreased peak extension, adduction, and internal rotation angles have been described in patients with FAI.<sup>24</sup>

**Palpation:** Palpate the anatomic landmarks (iliac crest at the level of L4, anterior superior iliac spine, greater trochanter, and pubic symphysis) for evidence of intra- or extra-articular pain.<sup>9</sup> The greater trochanter should be palpated to evaluate for overlying trochanteric bursitis or iliotibial band irritation. While passively moving the hip, palpate anteriorly for a snapping psoas tendon. The psoas bursa below the inguinal ligament should be palpated. Neurologic examination of the lower extremities should be performed.

**Active and passive range of motion:** Flexion of the hip past 90° might be limited or painful. Internal rotation and abduction of the hip might also be painful. Observation of any popping, snapping, or clicking is important.

**Specialized tests for FAI:** The FADIR (flexion, adduction, and internal rotation) test and the FABER (flexion, abduction, and external rotation) test are 2 impingement tests for the hip joint. The FADIR test, also commonly referred to as the *anterior impingement test*, involves bringing the affected hip into a 90° flexed position with the patient lying supine and concurrently adducting and internally rotating it. The FABER test elicits posterior impingement, and it involves bringing the hip into a flexed, abducted, and externally rotated position. A sudden or sharp pain indicates a positive result. These tests have high sensitivity, specificity, and positive predictive values for identifying labral pathology and intra-articular causes of pain.<sup>25-27</sup>

**Imaging.** Definitive diagnosis of FAI requires imaging confirmation. Imaging is also helpful to exclude other conditions in the differential diagnosis. In general, imaging studies for FAI attempt to identify a certain degree of limitation or impingement within the hip joint that could be associated with increased wear on the cartilage.

**Plain film radiography:** Plain film radiography is the initial imaging method of choice. Commonly used views, depending on availability at local imaging centres, include the anteroposterior pelvis view, the Dunn view, the cross-table lateral view, and the frog-leg lateral view.<sup>8,11,28</sup> The Dunn view is performed with the patient supine on the x-ray table, with the symptomatic hip being flexed 90° and abducted 20° while maintaining neutral rotation.<sup>28</sup> The cross-table lateral view is performed with the patient supine with the contralateral hip and knee flexed beyond 80° and the symptomatic hip internally rotated 15°, in order to expose the anterolateral surface of the femoral head-neck junction.<sup>28</sup> The frog-leg lateral view is performed with the patient supine on the x-ray table with the symptomatic limb flexed at the knee approximately 30° to 40° and the hip abducted 45°.<sup>28</sup>

Important radiographic signs are summarized in **Table 1**. These signs have a high sensitivity and specificity for identifying patients with symptomatic FAI from population-based controls.<sup>29</sup>

**Figure 3** illustrates an increased alpha angle that suggests the presence of a bony prominence in the femoral head-neck area, the hallmark of cam-type FAIs. An increase in the lateral centre edge angle indicates overcoverage of the femoral head-neck, suggestive of pincer-type FAI; **Figure 4** shows a negative finding.<sup>11,30</sup>

Radiography is sufficient for the diagnosis of most cases of FAI in the correct clinical setting, and should be ordered by primary physicians initially. The decision

to order computed tomography or magnetic resonance imaging (MRI) could be left to a musculoskeletal specialist (sports medicine or orthopedics) to further study the degree of soft tissue changes, as this affects surgical decision making.

**Computed tomography and MRI or magnetic resonance arthrography:** Computed tomography and MRI or magnetic resonance arthrography might assist in further detailing subtle deformities and aid in preoperative planning.<sup>8</sup> Computed tomography is not part of the routine workup for FAI owing to concern about radiation exposure in young patients.

**Diagnosis.** The diagnosis of FAI can be suspected on clinical presentation and physical examination and confirmed with imaging. With a meaningful clinical history and relevant physical examination findings, the differential diagnosis includes symptomatic FAI, groin muscle strain or ligament sprain, labral tears, chondral injury, OA, infection, fracture, incipient inguinal hernia, and adductor tendinopathies. Referred pain from the lumbar spine or knee and trochanteric bursitis could also be considered, but they rarely cause anterior groin pain. Many of these conditions can coexist with symptomatic FAI and be related to it. Conversely, as a substantial proportion of patients with FAI seen on radiography are asymptomatic, the FAI findings might be incidental.

If there is concern regarding FAI, the patient should be referred to a sports medicine physician, rheumatologist, or orthopedic surgeon.

### Management

**Conservative options:** It is not currently recommended to treat asymptomatic patients with incidental findings of FAI,<sup>9</sup> although patient education and periodic reassessment is advised.

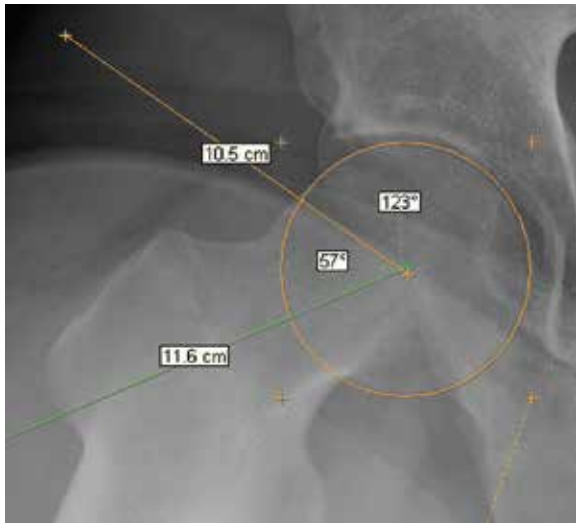
**Table 1. Description and definition of radiographic femoroacetabular impingement signs**

RADIOGRAPHIC SIGN	DESCRIPTION	DEFINITION OF POSITIVE FINDING
Alpha angle	Angle formed by the axis of the femoral neck and a line connecting the centre of the femoral head to the point where the contour begins to stray from a spherical radius	>55° on Dunn view and >42° on frog-leg lateral view
Increased acetabular depth	Protrusion of the acetabular fossa medial to the ilioischial line (coxa profunda), or protrusion of the femoral head medial to the ilioischial line (protrusio acetabuli)	Findings on AP radiograph
Lateral centre edge angle	Angle between a line through the centre of the femoral head, perpendicular to the transverse axis, and a line through the centre of the femoral head, passing through the most superolateral point of the sclerotic weight-bearing zone of the acetabulum	>40° on AP radiograph
Crossover (figure-eight) sign for focal acetabular retroversion	Anterior acetabular rim lies lateral to posterior rim in the cranial part of the acetabulum, then crosses the posterior rim in the distal part of the acetabulum. Considered a negative result if the cross happens superior to the femoral head	Presence on AP radiograph

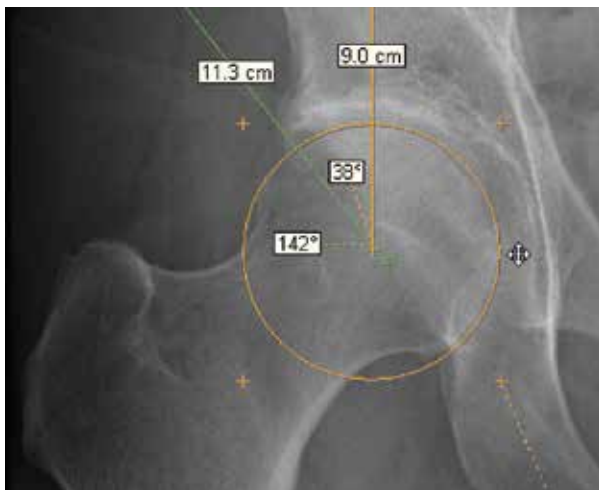
AP—anteroposterior.



**Figure 3.** A positive finding for cam-type impingement: Alpha angle of 57° seen on the Dunn view.



**Figure 4.** A negative finding for pincer-type impingement: Lateral centre edge angle of 38° seen on the anteroposterior view.



In symptomatic patients, conservative management options should be tried before referring the patient for more invasive methods.<sup>9,31</sup> Management options include rest, modification of activities involving excessive ranges of movement, acetaminophen or nonsteroidal anti-inflammatory medications, and physiotherapy.<sup>8</sup> The physiotherapist should be experienced in managing patients with FAI. The key focus of the sports or orthopedic physiotherapist should be determining if impingement can be reduced and range of motion increased through manual treatment and manipulation and maintained through neuromuscular exercise retraining. If impingement cannot be reduced and range of motion

cannot be increased, referral to an orthopedic surgeon should be considered. An increase in range of motion should not be forced through end-of-range stretching into impingement positions, nor should exercise or movement into impingement positions be employed if the patient is symptomatic. Strategies should be given to modify posture and movement during activity to limit extreme ranges of motions.<sup>10</sup> Surgical intervention is indicated if conservative options fail to alleviate symptoms or restore the previous level of function.

**Surgery:** The main goal of surgery is to improve fluidity of motion of the hip joint by alleviating the impingement of the femoral head and neck against the ring of the acetabular labrum. Therefore, surgery for FAI aims to correct the areas of excess acetabular coverage (pincer FAI) or bony femoral head-neck protrusion (cam FAI) to restore the normal clearance within the hip joint.<sup>32</sup> Operative management of FAI has been shown to be effective in providing symptomatic relief and improving function, and it is substantially better than non-surgical management.<sup>33-36</sup> It is currently unknown if any treatments of FAI will alter the natural history of the disease progression of OA or future need for hip replacement.<sup>37</sup> Data from randomized controlled trials are lacking, although several trials are under way.

Arthroscopic surgery has an advantage over open surgery in that it is minimally invasive, with faster rehabilitation and lower rates of complications.<sup>33</sup>

Open surgeries are substantial operations that involve dislocating the femoral head from the acetabulum and reshaping the acetabular rim or femoral neck to decrease bony impingement of the cartilage.<sup>37</sup> So far, there is no evidence that this approach provides superior symptomatic relief to the arthroscopic approach.<sup>10,33</sup>

## Conclusion

Femoroacetabular impingement is a prevalent condition that is well described but that has been largely unknown to health care providers outside the specialized fields of musculoskeletal medicine and surgery. Femoroacetabular impingement is an important cause of anterior groin pain and might be an important cause of hip OA in the adult population. Patients with persistent hip pain for whom conservative management failed might be referred to an orthopedic surgeon experienced in this area for further evaluation. Prevention of OA and resultant total hip arthroplasty might be possible; therefore, early recognition and intervention make the role of the primary care provider critical.

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## Contributors

All authors contributed to the literature review and interpretation, and to preparing the manuscript for submission.

## Competing interests

None declared

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